Toxicity-Based Chemical Agent Detection Systems: Continuous Monitor and Exposure History

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This project will develop and characterize chemical agent detection systems that will provide broad toxicological screening information to first responders and building decontamination personnel. The primary goal for this technology is to detect the presence of airborne chemical agents that will damage metabolic or neurological function. The anticipated applications with respect to building decontamination will be first, to provide a time integrated record of chemical toxins that have been present in the air over a specified time period; and second, to provide a short term screening system to determine the current toxicological status of the local building environment. One of the unique features of this technology is that the proposed techniques will be used to characterize a broad range of compounds and agent simulants that are toxic but not expected to be detected by currently available chemical sensor technologies. The ability to detect toxic chemicals on the basis of their potential biological/biochemical function is expected to provide the basis of a rapid response chemical hazard detection system. The proposed sampling technology will also provide a time-integrated chemical exposure record for numerous locations throughout the building. The following subtasks will outline critical research for the development and characterization of this toxicological screening system. Continuous and time-integrated sampling of indoor air will be accomplished using semipermeable membrane devices (SPMD) consisting of polyethylene tubing containing a thin film of high molecular weight neutral lipid such as triolein. The accumulation of semivolatile organics through the approximately 10 Angstrom pores and into the organic phase appears to be similar to transport of organic vapors through biomembranes during respiration. SPMD sampling devices will be interfaced to two types of biochemical detection systems. These will include an enzyme system for detection of organophosphate insecticides and the “nerve agent” class of chemical warfare agents; and a general toxicity assay based on luminescent bacteria for the detection of metabolic inhibitors and membrane disrupting toxins. Studies will be conducted to compare the proposed toxicity screening system to an Ion Mobility Spectroscopy (IMS)-based technology that has been validated through the soldier biological chemical command (SBCCOM).

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